DETAIL JAPANESE LEGAL STATUS

PATENT ABSTRACTS OF JAPAN

(11)Publication number : **05-116993**
(43)Date of publication of application : **14.05.1993**

(51)Int.Cl. **C03C 17/36**

(21)Application number : **04-109434**
(22)Date of filing : **28.04.1992**

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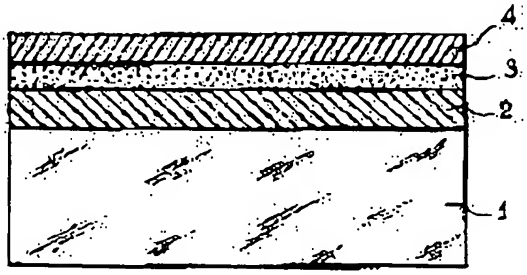
(30)Priority

Priority number :	91 9105328	Priority date :	30.04.1991	Priority country :	FR
	91 9105329		30.04.1991		FR
	91 9105330		30.04.1991		FR

(54) GLASS SUBSTRATE COATED WITH THIN MULTIFILMS FOR PROTECTION AGAINST SOLAR RADIATION

(57)Abstract:
PURPOSE: To provide a glass substrate provided with thin multifilms with an effective protection function against solar radiation.
CONSTITUTION: This glass substrate 1 is provided with the thin multifilms provided with a functional film 3 based on the metal alloy of chromium and nickel or based on tantalum stuck on a film 2 based on titanium oxide, tantalum oxide or tin oxide and coated with the film 4 of a metal compound like the titanium oxide, titanium nitride or the tantalum oxide.



DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application]this invention relates to the glass base material provided with the field of the windowpane for insulating and/or protecting to solar radiation, and the film with thin functionality made to adhere under a vacuum when saying in more detail.

[0002]

[Description of the Prior Art]This kind that has a multiplex film of substrate will be for equipment of a building or a marine vessel, if it says in this case more in detail. As a matter of fact, it contributes to it controlling the energy expenditure which makes it possible to avoid indoor unpleasant excessive heating especially in a summer, and is needed in this way for air conditioning of the room by working on the quantity of solar radiation energy. It is remarkably important for this point from being today's tendency to make the rate of area of having inserted in the exterior glass window of the building increase.

[0003]However, other necessary conditions exist in making such a substrate that has a film into what was dramatically suitable for using it in a building, and especially the most important necessary condition is the endurance of a thin film, when it is what a windowpane tends to use as a windowpane of an integral.

[0004]It is important for this substrate actually covered with the thin film that it is suitable for using it with an integral windowpane. As they are this use in the inside of a double glazing type doubling windowpane or a multiplex windowpane, even if it is not protected, it is premised on being tolerance in time. By the way, a film thin in an integral windowpane, Also to the attack by friction which scratches also to the attack of mechanical properties, for example, and makes a crack, and results in an exterior defect also in reflection also in a penetration. The attack at the time [according to / the hygroscopic surface moisture of a circumferential atmosphere and/or contact with a contaminant, or an attack of chemical nature / for example] of a windowpane being made clarification with chemicals is also direct used.

[0005]The necessary condition of esthetic character must not be forgotten, either, and the windowpane shows the light soft tone which rather especially settled down various hue, when seeing reflection of the outside.

[0006]Although speaking of construction of a building that may be [in the case of a car] right, for example in the case of a windshield, but it is not a reason in which it is required always to use the very high windowpane of the transmissivity of light. Nevertheless, it is advantageous that a type

windowpane with various grades of the transmissivity of light can be provided.

[0007]About the method of making a thin film, the art of making it adhering is especially well known under the vacuum using cathode sputtering, and this makes it possible to fully control the optical performance of the film obtained. The art performed under existence of the magnetic field which makes the collision of the ion to a target increase and promotes adhesion especially is known. the [for example, / which proposes the method of using a monotonous magnetron / West Germany patent] -- the 2463431-C No. 2 specification and the U.S. Pat. No. 4116806 specification using the target which carried out the form of the belt known as a "belt track" can be mentioned.

[0008]The reactant cathode sputtering art which makes it possible similarly to make a thin film by making the material of a target react to the gas of plasma is known, for example, a U.S. Pat. No. 3907660 specification presents the method of making a metallic oxide depositing on glass.

[0009]the film which uses a chromium nickel alloy or an iron-chromium nickel alloy as a base material is known in effective metal or other thin films by reducing energy transmittance T_E by both absorption and reflection especially to solar radiation. For example, especially a U.S. Pat. No. 4022947 specification proposes the substrate of glass provided with the film produced from one of the alloys of these, and the film of the oxide corresponding to the alloy. This oxide film is arranged between the functional film top made to adhere to a substrate in itself or a substrate, and its functional film. This protection is not counted on although there is protective work in it intrinsically in the case of the former. In the case of the latter, there is work which prevents coloring from changing by the side of glass intrinsically in it, but the purity is not shown.

[0010]Therefore, the purpose of this invention achieves a protection function effectively to solar radiation, and it is mechanically and chemical very tolerance in the film side, and it is obtaining the substrate which has a thin multiplex film which makes variegated the color tone by the side of glass, and purity of a reflective color.

[0011]

[Means for Solving the Problem and its Function and Effect]According to this invention, a glass base material contains a functional film of a metal alloy in an essential target which uses chromium and nickel as a basc material. An alloy may contain iron other than these two metal, therefore may belong to a system of stainless steel (for example, thing like 316L steel by A.I.S.I. standards). . 10-100 nm of less than 100 nm of the thickness may especially be preferably sufficient. As a matter of fact, this film gives the solar radiation protection characteristic to the last windowpane by reducing a value of T_E. Another functional film according to this invention uses tantalum as a base material, and the thickness is adjusted according to desired light transmittance.

[0012]If it is in this type of film, many from 50% of solar energy A wavelength range between 0.38

nm and 0.78 nm, That is, when it is in a visible range, it should note that it is impossible to act on transmissivity T_E of energy, without acting also on transmissivity T_L of light. Only as a function of tolerance level of a country where the last windowpane merely tends to be used from this according to thickness of an alloy film to be used, but, A windowpane which has "put together" of versatility of a value of T_L respectively corresponding to an appropriate compromise between sufficient penetration visibility and the permissible thermal amenity and a value of T_E will be provided. But generally thickness remains in less than 100 nm.

[0013]Since cost is easily [processing] moderate advantageously, an alloy which uses nickel chromium as a base material is used. This type of alloy is easy to use it, since adhesion by cathode sputtering can be performed at a quick speed. The characteristic is also advantageous at a point of having good performance and having the emissivity which improved especially. That both nickel and chromium exist makes appearance of reflection of a windowpane of a side supporting a film comfortable to an eye again. When an alloy contains nickel and chromium intrinsically, a mass ratio of nickel versus chromium is about 55/45.

[0014]This film that uses metal and/or metallic compounds according to this invention as a base material is arranged on a metallic-oxide film (the following "lower layer film" is called) by which itself was made to adhere directly to up to a glass base material. It is further covered with another film (it calls in a word of the following "upper film") of metallic compounds.

[0015]A lower layer film uses tantalum oxide Ta_2O_5, tin-oxide SnO_2, or titanium oxide TiO_2 as a base material advantageously, and the thickness is 10-220 nm. There is an interference function for acting on appearance of reflection of light of a windowpane other than it having a function of Mie, namely, it promoting adhesion in a substrate of a functional film for the remarkable thickness, and there are main functions about the physicochemical tolerance of the whole stacked body of a film. As artificers were actually shown in the following example at a surprising thing, character of a lower layer film proved being an action under an attack of a film stacked body, and that it is not unrelated to an action in particular of a chemical kind.

[0016]For example, on a level of a lower layer film, if a lower layer film is not chosen suitably, if specified more, by glass / lower layer film interface, chemical etching may arise, and this corrosion will cause local destruction of a lower layer film, and, for this reason, separation of other layers will be caused. Here, an oxide selected for a lower layer film suits preferably being tolerance especially chemically, therefore achieving this function to both hygroscopic surface moisture and contamination, to a dramatically advantageous thing.

[0017]An upper film is metallic compounds, a division oxide, or a nitride, and is an oxide of titanium, a nitride, i.e., TiO_2, or TiN preferably, or is tantalum oxide Ta_2O_5. Besides, a layered film has the

main functions in which it is mechanical because of a wrap functional film, and protects chemical nature. It can also be contributed to the thickness and appearance which a role of interference may be played again according to it of a functional film, and is reflection of a windowpane in this way. The thickness is a maximum of 100 nm, and is at least 5 nm preferably.

[0018]Therefore, a substrate provided with these thin films is suitable for using it as a single-type windowpane, or using it, making it together with another substrate. It is construction and shipbuilding, and is an automobile industry, and can be used advantageous because of a field in which a window which does not need that a value of T_L is dramatically large is inserted.

[0019]One type of a film stacked body according to this invention which makes it possible to attain the purpose of this invention, A lower layer film (2) about 100 nm thick preferably which uses tantalum oxide Ta_2O_5 as a base material, Tantalum is used as a base material and a metallic film (3) which suited attaining 11% of last T_L about especially, and thickness which uses Ta_2O_5 as a base material too specify a 14.3-nm upper film (4) about preferably.

[0020]Details of the advantageous feature of this invention will become clear from the following detailed explanation of a substrate which is made with reference to an attached drawing and which has a thin film by this invention. In an attached drawing, since it is going to make it intelligible, a ratio of thickness does not have a fixed ratio.

[0021]Although adhesion of these thin films is altogether performed preferably by magnetron cathode sputtering art in inside of a reactant atmosphere following other things on a substrate, It must describe that arbitrary adhesion art under a vacuum which makes it possible to control thickness of an adhering film good could probably perform them.

[0022]The substrate 1 of ******- soda lime glass and a division float glass is introduced by a pressure reducing device at a sputtering room of adhesion equipment. This sputtering room is equipped with the negative pole which has a target of material corresponding to an affix which should be made to adhere.

[0023]Follow a substrate, it is made to pass through the bottom of a metal target in a suitable atmosphere, and the films 2, 3, and 4 are adhered. In order to form the lower layer film 2, a target is tantalum, titanium, or tin, and atmosphere comprises argon and oxygen intrinsically and is managed. In order to form the functional film 3, a target is an alloy or tantalum, and adhesion is performed in atmosphere of argon/nitrogen, argon and in order to make a nitriding film of nickel chromium again depending on things. In order to form the upper film 4 (an example is especially related to an upper film of an oxide here) of an oxide or a nitride, a target of titanium or tantalum is used and atmosphere of argon/oxygen (or a case of a nitride argon/nitrogen) is used.

[0024]power level applied to each of the negative pole as known -- and speed of movement of a

substrate is also adjusted again so that desired thickness may be obtained for a film. However, as well known to a specialist who works with the equipment for making a film adhere under a vacuum. In order to obtain by carrying out, without deciding very correctly systematically thickness of a film which makes it possible to obtain a value of this T_L dramatically precisely [$_L$ / desired / light transmittance T]. As long as it is that the purpose controls various adhesion conditions thoroughly for every type of equipment, exact thickness of the functional film 3 is directed without a place which is left in all the cases, and an end does not have it.

[0025]The appearance of reflection of a substrate provided with a film by this invention in the first place should express being judged with the following three values first. . In consideration of a standard light source instructed to be those three values in a term of sensitivity and light source D_{65} of an eye, are given with shape of a reflection spectrum of a visible Mitsunori enclosure of a substrate. It is the excitation purity pe (R_1L) which shows value R_1L of extraneous light reflection by the glass side, a value (let nano meter be a unit) of dominant wavelength lambda $_{dom}$ (R_1L) which shows a color of catoptric light, and chroma saturation of this color.

[0026]A value of a light reflex in a side which has the inside, i.e., a thin film, is directed to below by R_2L.

[0027]An examination used in order to evaluate mechanical resistance of a stacked body of a thin film by this invention is specified next.

[0028]- A wear test which makes it possible to evaluate mechanical resistance of a film is done using a grinding stone made from abrasives powder embedded at an elastomer. Machinery is a product made from Taber Instrument Corporation of an American company. It is Standard Abrasion Tester of the model number 174, a grinding stone is a thing of type CS10F, and load of the 500 g is carried out. rotating each specimen 300 times -- wavelength of 550 nm -- transmissivity of light -- polish -- front (tau_0) -- back (tau_{300}) It measures. Abrasion loss is measured with the following value U.

U %=tau_{300}-tau_0[0029]The standard chemical corrosion resistance test done is as follows.

- A withstand type test to contact with neutral salt water mist and salt water mist of copper acetate according to DIN 50021 standards. If it says in detail. when these examinations expose a stacked body to a standard laboratory atmosphere corresponding to these two examinations, they will become a stacked body of a thin film from measuring a period (days) which will pass by a time of the first defect appearing.

[0030]- Examination SFW 2 about tolerance to sulfur dioxide SO_2, and OS DIN 50018 standards are followed. A period (the number of cycles which makes one cycle exposure of 8 hours and a pause of 16 hours following it) which will pass by the time change specified in the following by the same

principle as two examinations described previously appears is measured.

[0031]

[Example]

The first examples 1-4 aiming at one to example 5 limitation have a thin film which the catoptric light of the visible range by the side of glass colors blue, and are related with the substrate provided with the lower layer film 2 of tantalum oxide, and the upper film 4 of titanium oxide.

[0032]The metal target used in order to obtain the functional film 3 is Inconel (INCONEL) 671 by ASTM standards. Preferably, the sintered target which is obtained from the nickel powder and chromium powder of a suitable ratio is chosen here. Thus, although uniform sputtering is performed, the "particles" of a sufficiently small path is obtained.

[0033]In order to produce a nonmagnetic target, uniform counter diffusion should be attained among the two above-mentioned kinds of powder.

[0034]The substrate 1 is 6-mm-thick transparent ******- soda lime glass.

[0035]The thickness of the film 3 in each example is selected in order to obtain value T_L of desired light transmittance. In this case, thickness is between 10 nm and 100 nm like the following example 6 and Example 7.

[0036]Light transmittance T_L of the thickness (nano metric unit) of the lower layer film 2 of Ta_2O_5, the functional film 3, and the upper film 4 of TiO_2 and the collection object which contains a substrate / multiplex film again is shown in the following table.

[0037]

Example (2) Ta_2O_5 (3) $NiCrN_x$ (4) TiO_2 T_L 1 100 15 10 35% 2 100 28 10 19% 3 100 36 10 14% 4 100 45 10 8%[0038]By changing the thickness of the functional film 3 within the limits of the value shown previously shows that it is possible to obtain light transmittance T_L of the wide range. However, the value of such thickness for obtaining the value of predetermined T_L must state that the grade of nitriding of the alloy made to especially adhere to the conditions of adhesion rules over greatly in these examples.

[0039]In order to prove good performance when the substrate covered according to this invention is mechanical and it is exposed to chemical corrosive action, It compared between these four examples and Example 5 which comprised same stacked body of three films of the metallic oxide on the same substrate as Example 2 / the metal alloy/metallic oxide when saying more concretely. [nitriding / metallic oxide] The feature of each film of Example 5 is as follows.

[0040]- Lower layer film (2) : The mixture of a zinc oxide and the tin oxide, and 84 nm in thickness

- Film (3): Stainless steel according to A.I.S.I. standards 316 and 22 nm in thickness

- Upper film (4): Titanium oxide and 10 nm in thickness

[0041]The light measurement characteristic of Example 2 and Example 5 is approaching mutually, and it is understood that the column of the last of the table hung up over the next is pointing to the color of reflection by the substrate side.

[0042]

Example T_L R_1L R_2L T_E lambda$_{dom}$(R_1L) pe (R_1L) color R_1L 2 19% 18% 34% 20% 482 24% Blue 5 20% 17% 43% 17% 480 22% Blue[0043]Soft blue with both cases light in R_1L is obtained. By contrast, the value of R_2L of Example 2 is smaller than that of Example 5, therefore the catoptric light of a substrate according to Example 2 attached to the room as an integral windowpane can be softened by the thin film side (inside of the room when [Namely,] they are on the field 2). This makes it possible to restrict the "mirror" effect, when an extraneous light is weak and internal brightness is high.

[0044]By contrast, the result of having been dramatically different is obtained in the corrosion test about two covered integral substrates (an examination of these expresses a period until change equivalent to 10% of change of T_L appears in a film stacked body).

[0045]

**** ****** mist copper acetate mist sulfur dioxide 2 1.8 > 62>50>37 5 3.7 211 < 1[0046]It seems not to allow it to be used for the insufficient thing as a result of the chemical test of Example 5 as an integral windowpane on hygroscopic surface moisture and/or the extreme conditions of contamination.

[0047]By contrast, the film stacked body of Example 2 by this invention is shown, and the outstanding chemical resistance and it, The surprising compound effect of the lower layer film of Ta_2O_5, the functional film [nitriding / the functional film], and the upper film of TiO_2 is proved, And the service condition and/or climatic condition to which a windowpane is exposed standardly will make it possible to use the substrate which is what like and has this type of film stacked body in that and the field 2 as an integral windowpane.

[0048]Examples 6 and 7 -- this second example is related with the substrate in which reflective R_1L of bronze colors is shown to the value of about 20% of T_L, although three thin films are the things of the same character as correctly as the thing of previous Examples 1-4.

[0049]It is as follows when the thickness of the films 2 and 4 according to this invention is shown.

Example (2) Ta_2O_5 (4) TiO_2 T_L T_E color (R_1L) 6 37.5 10 19% 20% Deep bronze colors 7 12.5 10 19% 20% Light bronze colors[0050]Example 8 -- the lower layer film 2 of Ta_2O_5 shown in a substrate below in this example, and the functional film 3 of Ta -- and the upper film 4 of Ta_2O_5 is given too.

[0051]**(2) Ta_2O_5 : 100-nm-thick lower layer film.

**(3) Ta : Functional film for the sunlight protection of the thickness which suited obtaining about 11% of T_L.

**(4) Ta_2O_5 : Thickness Upper film of 14.3 nm.

[0052]The light measurement characteristic of this type of film stacked body is as follows.

[0053]

Example T_L R_1L R_2L T_E lambda$_{dom}$(R_1L) pe (R_1L) color R_1 L8 11.2% 9.4% 37% 14.5% 480 14.6% Blue[0054]The example of the 9-11th examples has a thin film which the catoptric light of the visible range by the side of glass colors bronze colors, and is related with the substrate provided with the upper film 4 and lower layer FIRUMUMU 2 which uses titanium oxide TiO_2 as a base material too which use titanium oxide as a base material.

[0055]The metal target used in order to obtain the functional film 3 uses intrinsically nickel-Cr alloy by Inconel 671, i.e., ASTM standards, as a base material about Example 9, and it is manufactured as previous Examples 1-7 explained.

[0056]At Example 10, it is a film (3). Also containing iron, a target is A.I.S.I. It is nitriding steel SST 316 by standards.

[0057]The substrate 1 is 6-mm-thick transparent float ******- soda lime glass.

[0058]The thickness of the film 3 is fitted so that value T_L of desired light transmittance may be obtained in each example. In this case, it comes between 10 nm and 100 nm.

[0059]Light transmittance T_L of the thickness (nano metric unit) of the lower layer film 2 of TiO_2, the functional film 3, and the upper film 4 of TiO_2 and the collection object which contains a substrate / multiplex film again is shown in the following table.

[0060]

Example (2) TiO_2 (3) Functional film (4) TiO_2 T_L 9 15 28 10 21% 10 15 28 10 21%[0061]In order to prove good performance when the substrate covered with this invention is mechanical and it is exposed to chemical corrosive action, among three examples. When said more concretely, it compared between Examples 11 which comprised same stacked body of three films of the metallic oxide on the same substrate as Examples 9 and 10 / the metal alloy/metallic oxide. [nitriding / metallic oxide] The feature of each film of Example 11 is as follows.

[0062]- Lower layer film (2): A zinc oxide, the mixture of the tin oxide, and 10 nm in thickness

- Film (3): Stainless steel by A.I.S.I. standards 316 and 20 nm in thickness

- Upper film (4): Titanium oxide and 10 nm in thickness

[0063]The light measurement characteristic of Examples 9 and 10 and the light measurement characteristic of Example 11 are approaching dramatically, and the column of the last of the table hung up over the next is understood that the color of reflection by the substrate side is shown.

[0064]

Example T_L R_1L R_2L T_E lambda$_{dom}$(R_1L) pe (R_1L) color (R_1L) 921% 26% 32% 18% 493 2.1% Light bronze colors 10 21%. 25% 30%17% 504 0.8% Light bronze colors 11 20% 25% 35% 17% 490 2.1% Light bronze colors[0065]In these three examples, the color of a very light soft bronze-colors tone is acquired by R_1L.

[0066]However, a dramatically different result is obtained in the corrosion test about three covered integral substrates (an examination of these shows a period until change of the film stacked body corresponding to the first visible defect appears).

[0067]

**** ****** mist copper acetate mist sulfur dioxide 9 2.5 > 78>90>20 10 1.5>78>90 5 11 2.1 14 1 1[0068]It seems not to allow it to be used for the insufficient thing as a result of the chemical test of Example 11 as an integral windowpane on hygroscopic surface moisture and/or the extreme conditions of contamination.

[0069]By contrast, the film stacked body of Example 9 by this invention, and Example 10, and also the film stacked body of the example 9 of division, The outstanding chemical resistance is shown and it The lower layer film of TiO_2. The surprising compound effect of the metallic film which uses as a base material nickel and chromium, and the upper film of TiO_2 is proved. [nitriding / chromium] And a windowpane is enabled to use too the substrate which the service condition and/or climatic condition which are exposed standardly are what like, and was provided with that and this type of film stacked body as an integral windowpane.

[0070]In these examples, the lower layer film 2 of TiO_2 with thin thickness which enables manufacture of the windowpane with which the bronze colors of reflective R_1L are judged to be quite convenient with a building was chosen. But it is clear by changing this thickness that the cross protection which makes it possible to change this color tone can be acquired by especially increasing it considerably. In that case, it can make it possible to provide the windowpane which this has T_L of various values and has a color of various reflective R_1L about each of these values, and selection of those thickness can be rightly performed easily in all the examples according to this invention.

[0071]The examples 12-15 aiming at 12 to example 15 limitation have a thin film which the catoptric light of the visible range by the side of glass colors blue, and are related with the substrate provided with the lower layer film of SnO_2, and the upper film of TiO_2.

[0072]The metal target used in order to make the functional film 3 is Inconel 671 by ASTM standards like the point.

[0073]The substrate 1 is 6-mm-thick transparent ******- soda lime glass.

[0074]The thickness of the film 3 is fitted in order to obtain the value of desired T_L in each example. In this case, it is between 10 nm and 100 nm like Example 16 and Example 17 which are shown below.

[0075]Light transmittance T_L of the thickness (nano metric unit) of the lower layer film 2 of SnO_2, the functional film 3, and the upper film 4 of TiO_2 and the collection object which contains a substrate / multiplex film again is shown in the following table.

[0076]

Example (2) SnO_2 (3) $NiCrN_x$ (4) TiO_2T_L12 85**5 15 10 35% 13 85**5 28 10 19% 1485**5 36 10 14% 15 85**5 45 10 8%[0077]In order to prove good performance when the substrate covered with this invention is mechanical and it is exposed to chemical corrosion, when these four examples were said more concretely, it compared between Example 13 and Example 5.

[0078]The light measurement characteristic of Example 13 and Example 5 is approaching mutually, and the column of the last of the following table is understood that the color of reflection by the side of a substrate is shown.

[0079]

Example T_L R_1L R_2L T_E lambda$_{dom}$(R_1L) pe (R_2L) color (R_1L) 13 19.5% 17.7% 38.6% 18% 481 25.9% Blue 5. 20% 17% 43% 17% 480 22% Blue[0080]Light and soft blue is obtained by R_1L in these two examples. The value of R_2L of Example 13 is smaller than that of Example 5 to it.

[0081]By contrast, a dramatically different result is obtained in the corrosion test about two covered integral substrates (an examination of these shows a period until change which results in the first visible defect appears in a film stacked body).

[0082]

**** ****** mist copper acetate mist sulfur dioxide 13 1.0>60>60>5 5 3.7 7 1 < 1[0083]It is clear that the result of the chemical test of Example 5 is insufficient.

[0084]By contrast, the film stacked body of Example 13 by this invention is shown, and the outstanding chemical resistance and it, The tolerance lower layer film of SnO_2, and the functional film [nitriding / functional film], I will prove the surprising compound effect of the upper film of TiO_2, and the service condition and/or climatic condition to which a windowpane is exposed standardly will make it possible to use the substrate which is what like and has that and this type of multiplex film stacked body in the field 2 as an integral windowpane.

[0085]Examples 16 and 17 -- although three thin films of the example of these are correctly [as the thing of the last examples 12-15] the same, it is related with the substrate whose reflective R_1L to the value of about 20% of T_L is bronze colors.

[0086]The thickness of the thin films 2 and 4 by this invention is as follows.

[0087]

Example (2) SnO_2 (4) $TiO_2T_LT_E$ color (R_IL) 16 30 10 19% 20% Deep bronze colors 17 10 10 19% 20% Light bronze colors[0088]In conclusion, all of these examples of application according to this invention are related with the windowpane in which the outstanding corrosion resistance is shown. It is possible to obtain the windowpane which has the spectrophotometry characteristic of the wide range.

[0089]For example, it is possible by changing the thickness of a functional film to choose desired light transmittance. The range of the light soft color of reflective R_IL is changeable by changing only the thickness of a lower layer film, maintaining the value of T_L at an almost fixed value.

[0090]Therefore, the color of reflective R_IL is various by changing both the thickness of a lower layer film, and the thickness of a functional film, It is obvious for light transmittance T_L and energy transmittance T_E to be able to obtain various substrates provided with the thin film about each of these colors.

[0091]In order to classify an upper film noting that it has a protection function, or in order to give it an interference function, it is also possible to choose the thickness of an upper film more thickly or more thinly.

[0092]By choosing thickness suitable about these films, it should note that it is also possible to adjust reflective R_2L.

CLAIMS

[Claim(s)]

[Claim 1]It is a glass base material which has a thin multiplex film containing a functional film which uses chromium and nickel as a base material, or uses tantalum as a base material, The functional film (3) concerned has adhered on a film (2) which uses titanium oxide, tin oxide, or tantalum oxide as a base material, And a glass base material, wherein a film (4) of metallic compounds which belong on the functional film (3) concerned at a group of titanium oxide, titanium nitride, and tantalum oxide has adhered.

[Claim 2]The substrate [nitriding / substrate / when said functional film (3) uses chromium and nickel as a base material] according to claim 1.

[Claim 3]The substrate according to claim 1 or 2, wherein said functional film (3) uses about 55/of nickel chromium of a mass ratio of 45 as a base material.

[Claim 4]A substrate of any one statement to claims 1-3, wherein said functional film (3) belongs to a system of stainless steel also including iron.

[Claim 5]A substrate of any one statement to claims 1-4, wherein thickness of said functional film (3) is less than 100 nm.

[Claim 6]A substrate of any one statement to claims 1-5, wherein thickness of a film (2) of said oxide is 10-220 nm.

[Claim 7]A substrate of any one statement to claims 1-6, wherein thickness of a film (4) of said metallic compounds arranged on said functional film (3) is 5-100 nm.

[Claim 8]On a substrate (1) of a 6-mm-thick transparent float glass, a film (2) of 100-nm-thick tantalum oxide, Subsequently, a film (4) of 10-nm-thick titanium oxide has adhered to a film (3) of NiCr [nitriding / NiCr / the mass ratios 55/45], and the next, respectively, A substrate of any one statement to claims 1-3 or claims 5-7 conforming to a substrate provided with a film whose thickness of the above-mentioned film (3) which uses as a base material NiCr [nitriding / NiCr] is these three having about 19% of light transmittance T_L.

[Claim 9]The glass base material according to claim 1, 5, 6, or 7 characterized by being covered with a film (4) which uses tantalum oxide as a base material too by a functional film (3) of tantalum adhering on a film (2) which uses tantalum oxide as a base material.

[Claim 10]Thickness of a film (2) of the beginning of said tantalum oxide is about 100 nm, Thickness of a film (4) of the last of said tantalum oxide is about 14.3 nm, And the substrate according to claim 9 conforming to a substrate provided with a film whose thickness of a film (3) which uses said tantalum as a base material is these three having about 11% of light transmittance T_L.

[Claim 11]On a substrate (1) of a 6-mm-thick transparent float glass, a film (2) of TiO_2 about 15 nm thick, Next, a film (3) of nickel chromium [nitriding / with chromium / the mass ratios 55/45], Next, a film (4) of titanium oxide about 10 nm thick has adhered, respectively, A substrate of any one statement to claims 1-8 conforming to a substrate provided with a film whose thickness of the above-mentioned film (3) of NiCr [nitriding / NiCr] is these three having about 21% of light transmittance T_L.

[Claim 12]On a substrate (1) of a 6-mm-thick transparent float glass, a film (2) of tin oxide about 85 nm thick, Subsequently, a film (4) of titanium oxide about 10 nm thick has adhered to a film (3) of NiCr [nitriding / NiCr / the mass ratios 55/45], and the next, respectively, A substrate of any one statement to claims 1-8 conforming to a substrate provided with a film whose thickness of the above-mentioned film (3) of NiCr [nitriding / NiCr] is these three having about 19% of light transmittance T_L.

[Claim 13]By reactant cathode sputtering under a vacuum supported by magnetic field, said film which is not pure metal a metallic oxide under existence of oxygen, A substrate of any one

statement to claims 1-12, wherein a functional film and/or a film of a nitride are made under existence of nitrogen. [nitriding / a film]

[Claim 14]A substrate of any one statement to claims 1-13 applied to a windowpane for protection to solar radiation for using it with construction or shipbuilding, or using it by an automobile industry.